



# Environmental Monitoring Plan

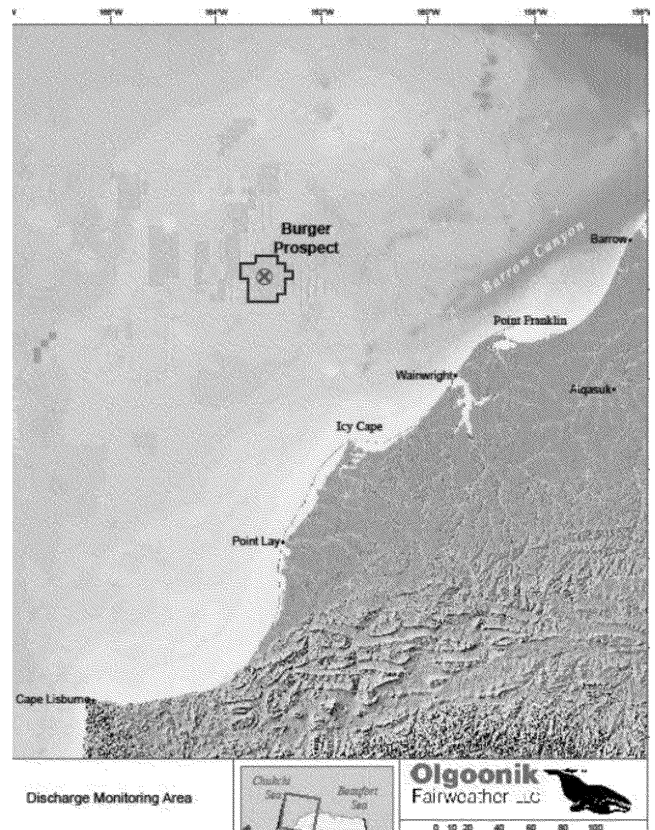


## Goals of the EMP

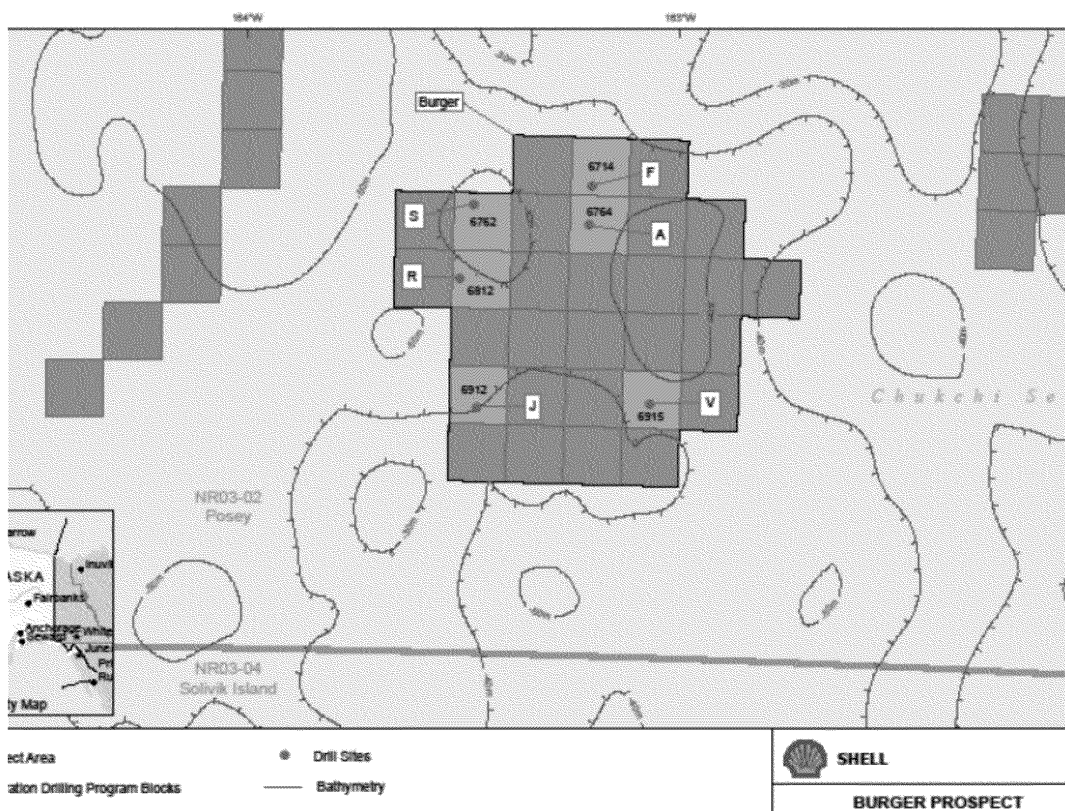
- Complete an initial site assessment, including a physical sea bottom survey, to ensure the exploratory facility is not located or anchored in a sensitive biological area or habitat;
- Evaluate water quality characteristics of the receiving water and potential effects of the specified discharges;
- Evaluate sediment characteristics of the seafloor and potential effects of the discharges on the sediment characteristics;
- Evaluate potential effects to the benthic community structure due to deposition of Discharge 001 (water-based drilling fluids and drill cuttings) and Discharge 013 (muds, cuttings and cement at the seafloor), which includes both spatial and temporal changes in community diversity and abundance; and
- Evaluate the suspended particulate and dissolved constituent plume(s) in the vicinity of the discharges.

## Chukchi Sea – Burger Prospect

- Chukchi Sea OCS
- About 70 miles offshore of Wainwright
- 40-50 meters of water
- Drilling during open water period (July – October)



## Six Burger Prospective Well Locations



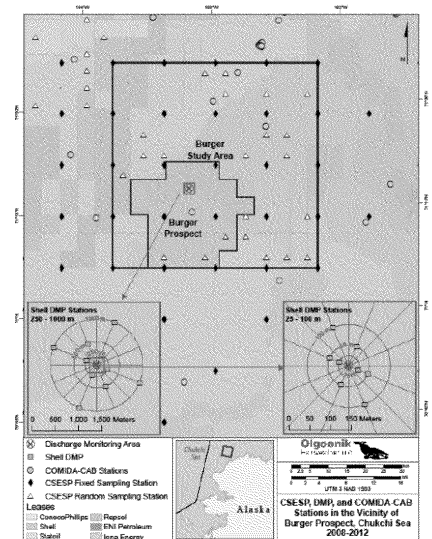


## Overall Approach – Four Phases

- The Phase I assessment requires a physical site characterization which includes:
  - An initial site physical sea bottom survey;
  - Physical characteristics;
  - Receiving water chemistry and characteristics, and
  - Benthic community structure.
- The Phase II assessment will be conducted during drilling activities and includes:
  - Effluent toxicity characterization;
  - Discharge 009 (non-contact cooling water) plume observations;
  - Water-based drilling fluids/drill cuttings metals analysis; and
  - Plume monitoring and observations.
- Phase III and IV assessments are conducted following the cessation of drilling activities at a drilling site. Phase III components will be conducted as soon as practicable immediately after drilling and include:
  - Physical sea bottom survey;
  - Sediment characteristics and discharge effects; and
  - Benthic community bioaccumulation monitoring.
- Phase IV assessments will be conducted no later than 15 months after drilling operations cease at a drilling site and include all components from the Phase III assessment with the addition of evaluation of the benthic community structure.

## Phase I – Existing data

- Multiple studies have been conducted in the Chukchi lease area generally and at the Burger prospect specifically since 2008
  - Chukchi Sea Environmental Studies Program (CSESP)
  - Chukchi Offshore Monitoring in the Drilling Area (COMIDA)
  - COMIDA Hanna Shoal
  - Pre-drill monitoring at Burger A
- Include
  - Physical Oceanography
  - Benthos
  - Plankton
  - Sediment chemistry
  - Tissue chemistry
  - Mammals
  - Birds
  - Fishes
  - Sea floor video
  - Nutrients



## Sufficiency of Existing Data - Appendix A

- Receiving water chemistry
  - Six samples from Burger
  - 88 samples from NE Chukchi
- Currency of data
  - Relative homogeneity of chemistry data & linkages to physical sediment characteristics
- Propose six fewer metals (Aluminum, Iron, Titanium, Silver, Antimony, Beryllium)
  - Low water solubility
  - Non presence in drilling related products
  - Analytical problems that produce a high likelihood of background contamination

Parameter	As	Ba	Cd	Cr	Cu	Total Hg	Ni	Pb	Sb	Se	Tl	Zn	TSS
Burger study area (2010; n = 6)													
Mean	1.16	7.7	0.046	0.13	0.24	0.0005	0.32	0.004	0.13	0.034	0.009	0.33	0.59
SD	0.04	1.2	0.024	0.07	0.04	0.0003	0.08	0.002	0.01	0.002	0.001	0.06	0.52
RSD <sup>1</sup>	3	16	52	54	17	60	25	50	8	6	11	18	-
Northeastern Chukchi Sea (2010; n = 88)													
Mean	1.15	8.2	0.046	0.10	0.27	0.0005	0.32	0.006	0.12	0.034	0.010	0.45	0.80
SD	0.12	2.0	0.021	0.02	0.10	0.0003	0.08	0.002	0.01	0.006	0.002	0.26	0.88
RSD <sup>1</sup>	10	24	46	20	37	60	25	33	8	18	20	58	-

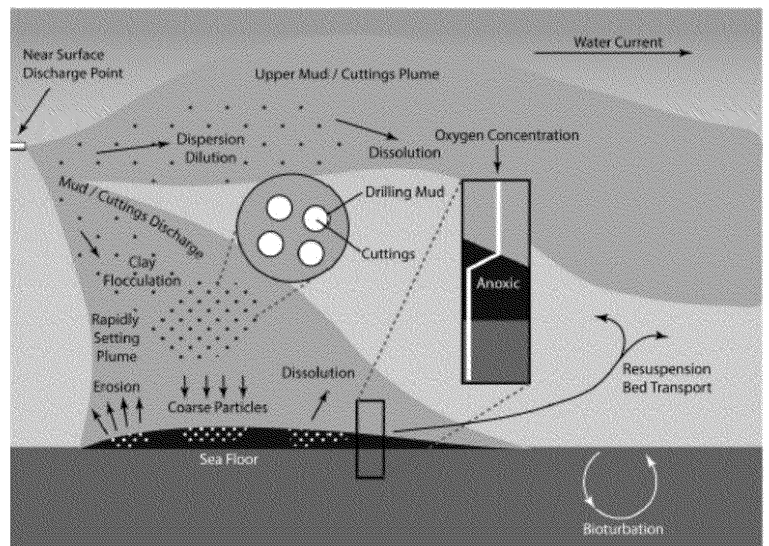
metals measurements = µg/L

TSS = mg/L

<sup>1</sup>RSD = (SD/mean) x 100%

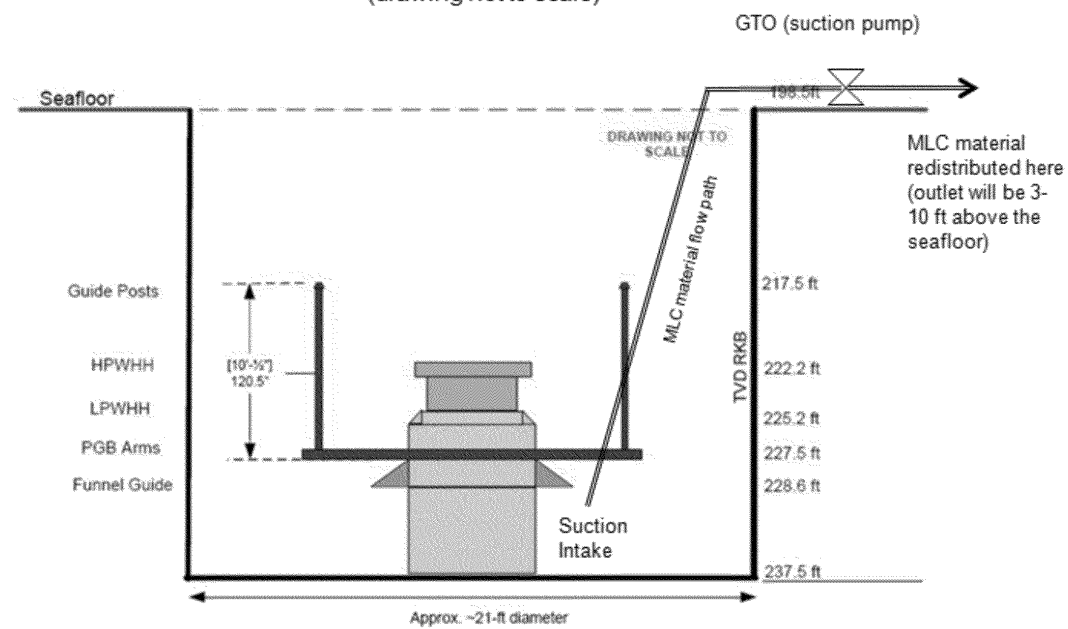
## Drilling Discharge Description

- During majority of drilling discharge 6 m below sea surface



## Drilling Discharge Description

### Burger A – MLC Materials Flow Redistribution (drawing not to scale)



## Numerical Modeling

- Offshore Operators Committee Mud and Produced Water Discharge Model better known as the OOC Model.
- GUIDO 7.0 - The OOC Model (v3.0) with Windows User Interface.  
Release date: 15 April 2013 by Fluid Dynamix, Alam Mohammad, Boston, MA
- Results generally consistent with Tetra Tech Technical Memorandum, Results from Beaufort/Chukchi Permit Dilution Modeling Scenarios, Nov 29, 2011.





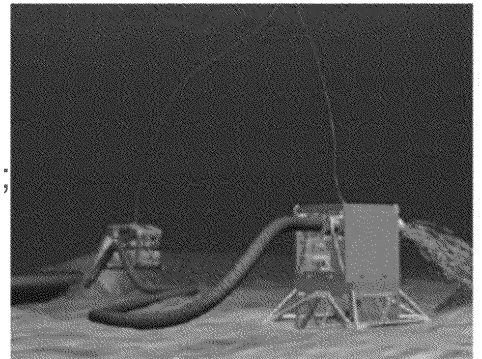
## Numerical Modeling

- Burger A Model Predictions

OOC Model Predictions												
Well ID	Discharge Scenario	Drilling Intervals	Duration of Drilling	Depth of Water	Depth of Discharge	Effluent Discharge Rate	Solids Deposition on the Seabed			TSS Concentration in Water Column (Distances from Source)		
							Area Covered by Solids Thickness		Maximum Deposit Thickness	100 m	200 m	500 m
							> 1 cm	> 1 mm				
			hours	m	m	bbl/hr	ha	ha	cm	mg/L	mg/L	mg/L
Burger A	Sea Floor	1	66.2	45.7	40.7	217.78	0.158	0.371	160.0	10 - 100	1 - 5	< 1
		2	5.2	45.7	40.7	190.78	0.086	0.117	19.0	5 - 10	1 - 5	< 1
		3	34.4	45.7	40.7	138.59	0.120	0.160	74.0	5 - 10	1 - 5	< 1
	Sea Surface	4	23.3	45.7	6.7	118.52	0.200	0.395	25.0	10 - 100	5 - 10	1 - 5
		5	29.0	45.7	6.7	61.67	0.182	0.340	15.0	10 - 100	1 - 5	< 1
		6	37.2	45.7	6.7	18.96	0.141	0.261	6.0	1 - 5	< 1	< 1
	Combined		195.3	45.7	varies	130.22	0.245	0.594	262.0	-	-	-
ha = hectare mm = millimeters												

## Numerical Modeling

- Seafloor mounted material transfer pump
- Similar volume of muds and cuttings discharged; greatly increased discharge/pumping rate and increased volume (more seawater).
- Maximum Total Suspended Solids concentrations at the seafloor were slightly higher. Max TSS occur during discharge from surface pits.
- Minimal effect on depositional loading and extent.



**For Burger J, the maximum area covered by 1 cm muds/cuttings equals approximately 0.2 ha (initial predictions) compared to 0.5 ha (revised predictions).**

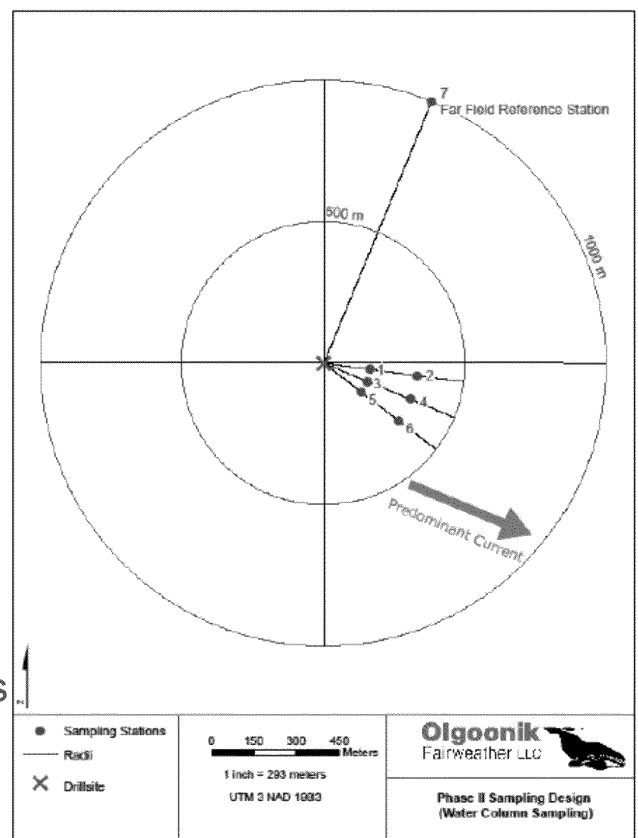
**Sea floor area impacted by deposited thickness larger than 10cm equals approximately 0.196 ha.**

## Phase II

- Toxicity characterization
  - Rapid screening utilizing Echinoderm fertilization
  - WET for samples that fail the initial screen
- Marine Mammal deflection
- Collection and analysis of muds and cuttings during drilling
  - Metals
  - Hydrocarbon – to inform post drilling sampling and analysis

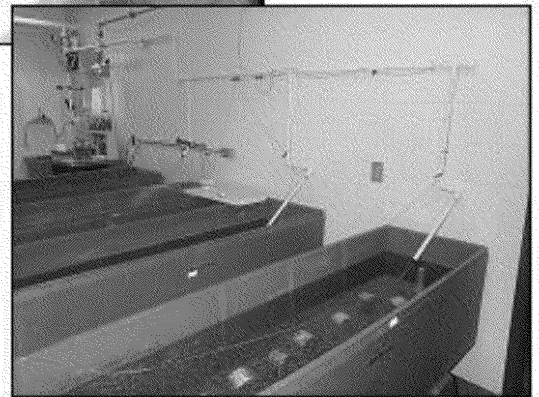
## Phase II – Plume monitoring

- Time points
  - Largest casing interval
  - Hydrocarbon zone
  - Bulk-mud discharge
- 7 sampling locations
  - Current speed and direction measured by on rig ADCP
  - Water samples at 5 depths – 1, 10, 20, 30 m depths & 2 above the seafloor
- Analyses – metals, TSS, organics – aromatics, PAHs, saturated

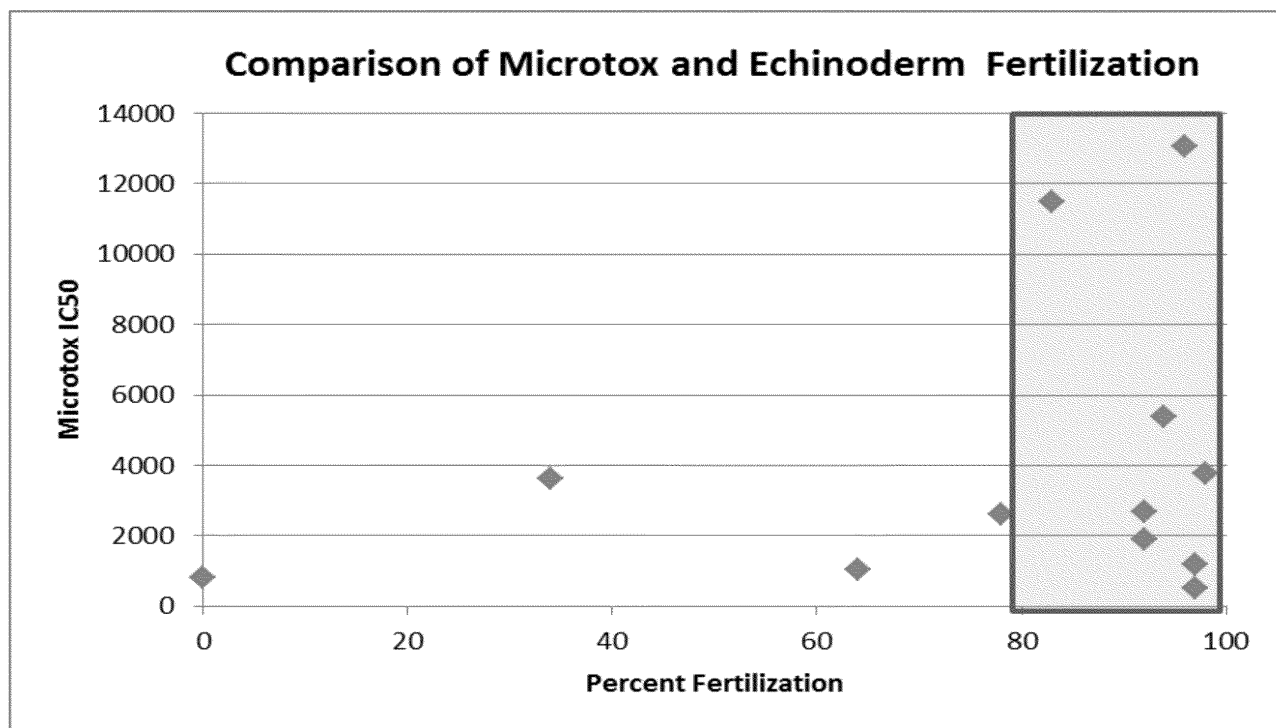


## Effluent Toxicity Characterization

- Water quality parameters will be measured prior to testing and modified, if necessary, (increase salinity with brine solution or artificial salts or reduce salinity (desalination discharge)) to achieve appropriate testing conditions.
- Rapid Screening Test – Comparison of Microtox™ responses and Echinoderm percent fertilization success.



## Effluent Toxicity Characterization



Acceptable echinoderm fertilization occurred over the entire solid-phase Microtox response range (526.9 to 13,080 mg/L) as shown in the blue outlined box.



## Phase III – Phase IV

- Sampling will occur @ 17 locations
  - Double Van Veen grab
    - Chemical analysis
    - Benthic community assessment
    - Biota tissue samples
      - Clams (*Astarte* & *Macoma*) and or amphipods
- Physical sea-bottom
  - Sediment profile imaging

